Space Weather Technical Forecast

Issued on Thursday, 14 March 2024 at 01:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1/R2 Radio Blackouts), reducing into the UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with only C-class flares observed, with a peak flare of C6.2 at 13/2349UTC. There are currently seven sunspot regions on the visible disc. AR3599 remains the largest and most complex region, with a north-south aligned delta region in its large leading portion, as it approaches the western limb. However, this region is now difficult to analyse due to its close proximity to the western limb and the foreshortening effect, and is due to rotate off the disc within the next 12 hours. AR3607 in the southeast, has displayed a spreading trend, now with small intermediate spots. AR3606 in the northeast remains largely unchanged. AR3605 in the southwest has faded. A new and currently unnumbered sunspot has emerged on the northeast limb, which is difficult to analyse at present due to foreshortening effect. The remaining spots are all small and simple at present. There were no Earth directed CMEs observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at L1 by ACE were fairly steady at slightly elevated levels (400-460 km/s). The solar wind density was generally below to around average. The Interplanetary Magnetic Field (IMF), Bt, was on a gradual rising trend but remained weak, rising from 4nT to 8nT through the period, with a north-south component, Bz, varying weakly between +6 and -7nT. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was mostly Quiet (Kp 1-2) with three Unsettled (Kp 3) intervals during the period.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux remained at background throughout.

High energy electron flux (greater than 2MeV) observed at GOES16 were mostly background to moderate, with a peak of 226pfu at 13/1635UTC. The observed 24-hour fluence showed a declining trend, with the 24-hour integrated fluence value at 14/0000 UTC being 6.23e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of M-class flares, most likely from AR3599. This sunspot is expected to remain on the Earth-facing side until the end of the current UTC working week, whereupon the risk of Moderate activity should fall.

Solar Wind / Geomagnetic Activity: A CME associated with the M7.4 flare from 10 March may pass Earth as a glancing blow early on Day 1 (14 Mar), although this is low confidence. Coronal hole fast wind activity is likely to be modest in the period, with a weak connection to CH09/+ possible on Day 1 (14 Mar), with perhaps a weak connection to CH10/+ currently near south-centre disc by the end of the period.

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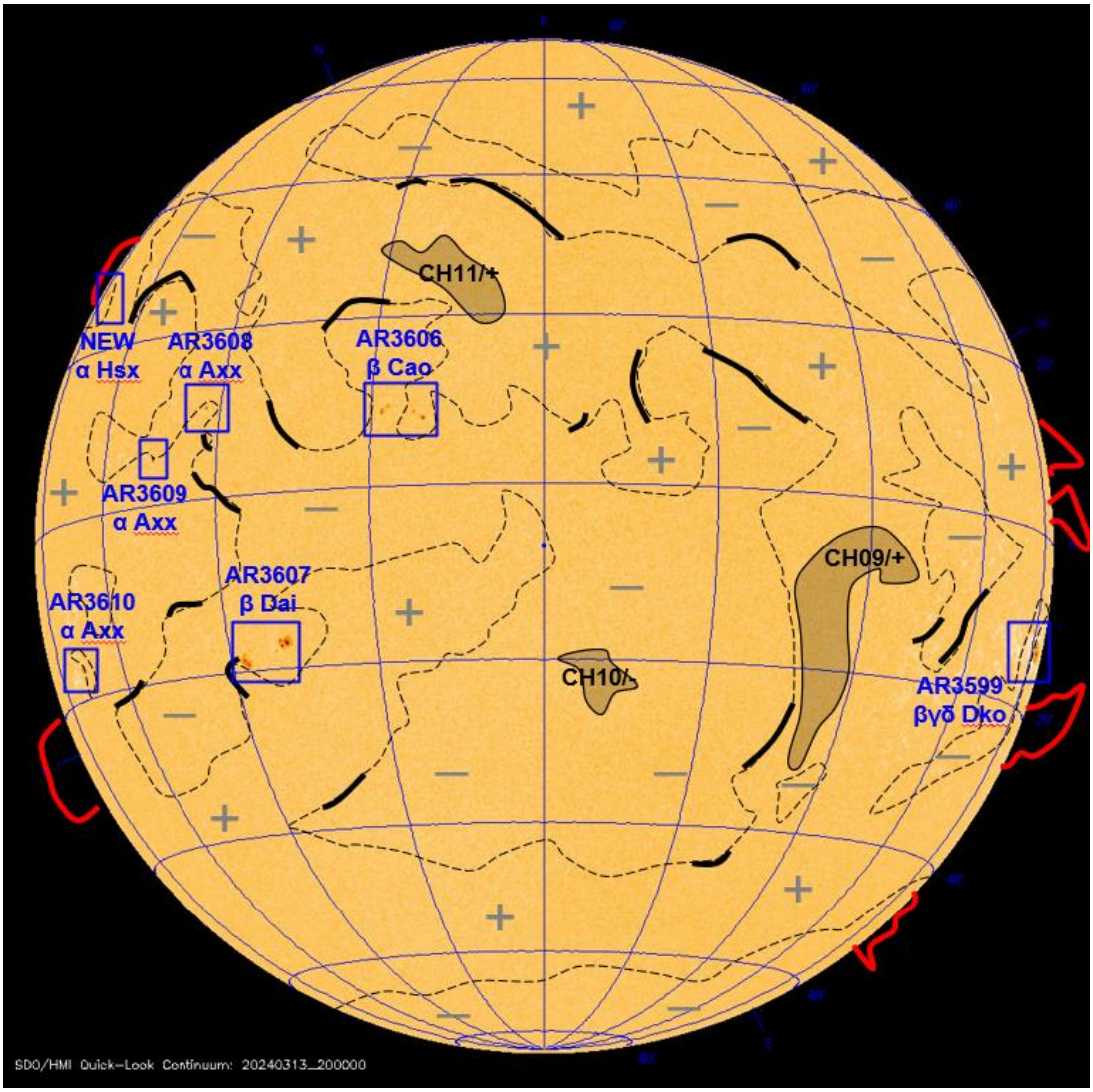
Mostly Quiet to Unsettled conditions are therefore expected over the next few days, with a slight chance of Active/G1 Minor Geomagnetic Storm early on Day 1 (14 Mar) should the 10 Mar CME and coronal hole fast wind materialise. Slight chance of Unsettled intervals by the end of the period, if we see a weak HSS from CH10/+ by end of the period.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to persist at background or close to background levels, with a very slight chance of S1 radiation storms, with the main risk from AR3599, especially early in the period.

GOES16 high energy electron flux is likely to remain near its current diurnal Moderate oscillation in the near term, with electron counts perhaps seeing a response at GEO upon the passage of the 10 March CME on early Day 1 (14 Mar) however this is deemed low confidence. Hence, 24-hr integrated fluence is likely to remain below the Active threshold.

Figure 1. Solar Analysis Valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME in the forecast, the M7.4 CME of 10 March, with this signalled to pass largely above and ahead of the track of the Earth in its orbit early on Day 1 (14 Mar). MOSWOC Enlil and its ensembles suggest there is a slight chance of a glancing blow as it passes Earth, albeit with low confidence.

The fast wind aspect of the forecast is also of relatively low confidence, with none of the current cohort of coronal holes particularly well-formed or having strong links to previous rotations. A connection from CH09/+ may occur through Day 1 (14 Mar), possibly combining with any CME arrival, however as this coronal hole is of a positive polarity it does not lend itself to producing a strong connection given the time of year and hence should have limited effects. A small negative polarity coronal hole, CH10/- may come into effect later on Days 3 and 4 (16-17 Mar) but this is low confidence at this point.

Mostly Quiet to Unsettled conditions are therefore expected over the next few days, with a slight chance of Active/G1 Minor Geomagnetic Storm on Day 1 (14 Mar) should the 10 Mar CME and coronal hole fast wind materialise.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0145UTC	Partial	M7.4 from AR3599	NW quadrant	300km/s	14/0000UTC	Glancing blow, low confidence

Figure 2: MOSWOC ENLIL and Ensemble.

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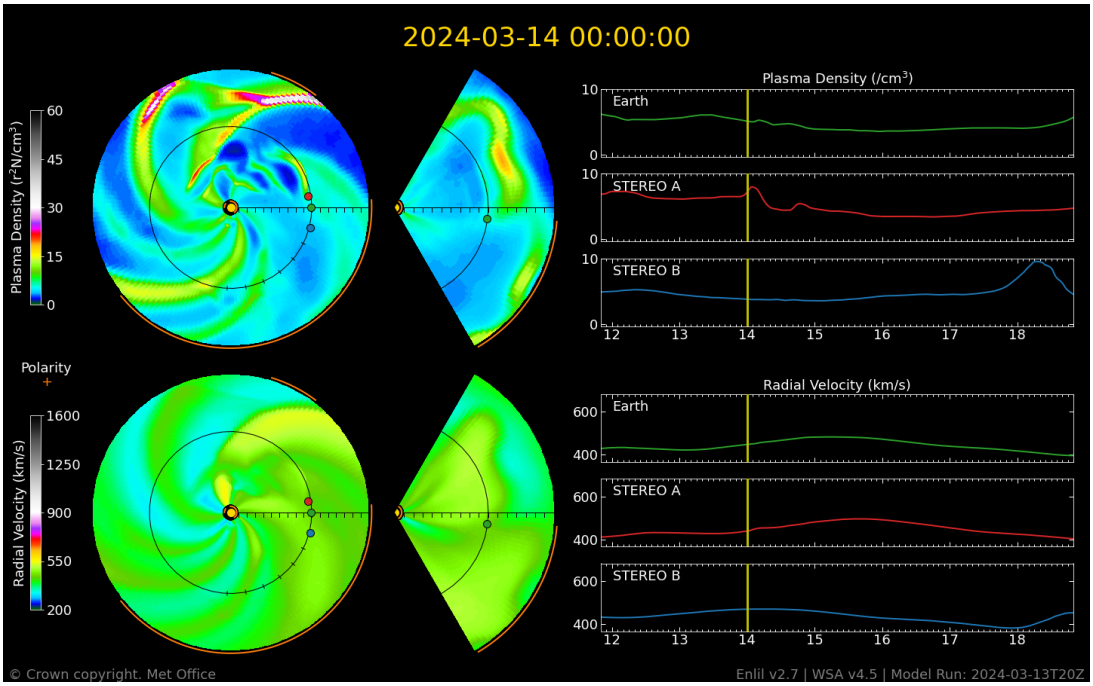

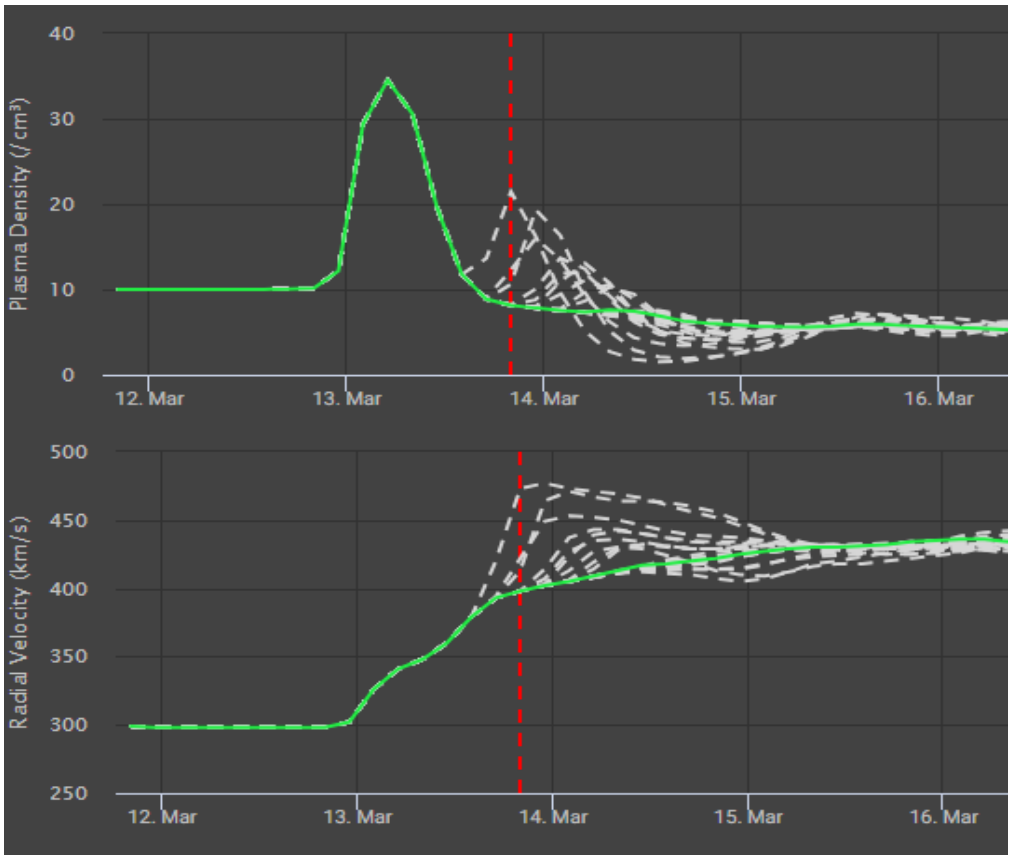

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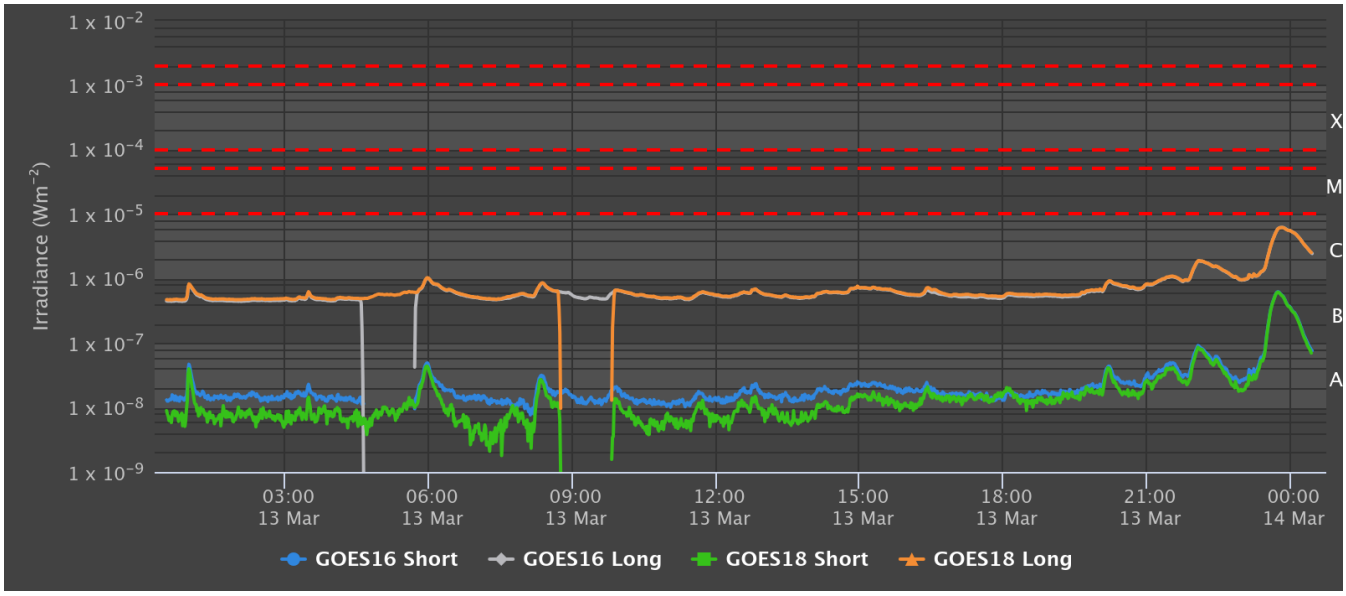
Radio Blackouts - X-Ray Flares:
There are six numbered regions on the visible disc. AR3599 remains the largest and most complex group, with a north-south aligned delta region in its large leading portion, as it approaches the western limb, accurate analysis is becoming increasingly difficult due to foreshortening effects. AR3607 in the southeast, continues a spreading trend. AR3606 in the northeast is showing a decreasing trend. AR3605 in the southwest has faded. A new and currently unnumbered sunspot has emerged on the northeast limb, which is difficult to analyse at present due to foreshortening effect. The remaining spots are all small and simple at present.

The X-ray flare forecast for the coming days mainly comes from the AR3599 sunspot region, and its passage around the western limb which is expected in the coming days. There remains a Chance of M-class flares, mainly from this region, with the risk then diminishing as it rotates around the limb. No significant returning regions are expected, albeit there may be a more active region rotating around the southeast limb in the next few days, with magnetic looping and minor flare activity visible in imagery.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	20	20	10
Very Active	R3 to R5 X Class	No	5	5	1	1

Figure 3: GOES X-Ray flux trace



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Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux levels are very closely tied to developments in AR3599, with no other sunspot groups of note. This feature proved capable of a very slight enhancement at GOES18 on 10 March in the wake of the M7.4 flare. The risk of S1+ therefore remains through the period as AR3599 advances to the western limb and slightly beyond in the coming few days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has shown a slight reaction to the recent CH07/- fast wind with flux levels reaching diurnal Moderate levels.

Further response of the electron belt could occur upon the possible passage of the 10 Mar CME arrival as well as CH09/+ coming into play, but both of these features are low confidence and are expected to have low impacts, hence any electron response is deemed unlikely. As a result, 24-hr integrated fluence is likely to remain below the Active threshold with only a slight chance of reaching this should the CME/coronal hole fast stream arrivals occur.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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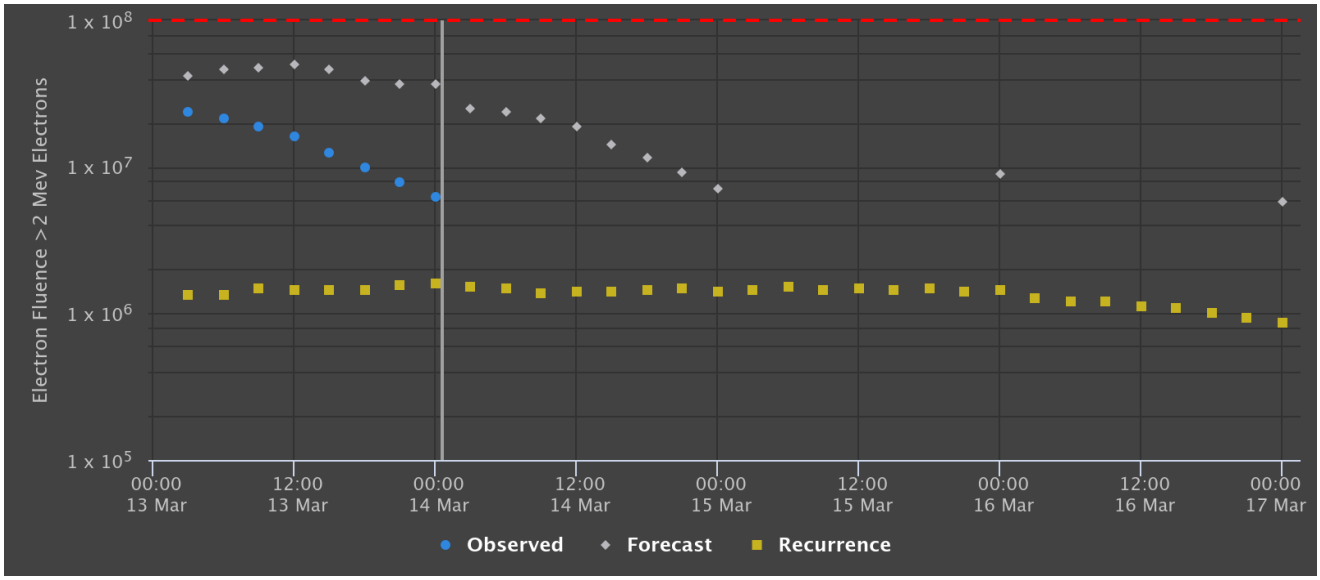
Figure 4: MOSWOC REFM electron fluence, observations and recurrence



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